LISBOA SCHOOL OF ECONOMICS & MANAGEMENT

MASTER OF SCIENCE IN

INTERNACIONAL ECONOMICS AND EUROPEAN STUDIES

MASTERS FINAL WORK

DISSERTATION

DETERMINANTS OF SOVEREIGN BOND SPREADS IN THE EMU

MANUEL GERARDO TELES REIS

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Abstract

An empirical investigation is presented on the determinants of 10-year Sovereign bond yield spreads of 11 EMU member states, *vis-à-vis* Germany. The determinants cover credit, liquidity and international conditions and the goal is to understand if the pricing is country and time –sensitive. It spans over the lifetime of the euro, up until the end of 2014. Panel and SUR analyses coupled with qualitative variables have confirmed the pricing of European debt has not been static across time and EMU countries. Market participants are increasingly aware of macro-economic and fiscal fundamentals.

JEL classification: C23; E43; G12; H60; E62

Keywords: Sovereign bond spreads; determinants; EMU

Contents

1. Introduction

There are three questions fitting to this introduction: How is sovereign debt priced?, Why is it interesting to engage in such an attempt? And why do it in the context of the European Economic and Monetary Union (EMU)?

Sovereign bonds are loans through which fiscal authorities at the country level fund their yearly budgets, as well as to service existing debt. To begin with the second question – Why is it interesting to engage in such an attempt? (at studying how debt is priced) – it is important to understand why one´s government pays a given amount of interest on its sovereign debt. To engage in such an experiment, it is crucial to try to understand how one´s country´s bonds are priced in the secondary market – hence the first question: How is sovereign debt priced? The existing literature puts forward a number of plausible determinants of sovereign bond yields that are used by market participants – institutional investors such as insurance companies and banks – and individual investors. Such indicators relate to a country´s macroeconomic and fiscal performance, but also to other reasons that might weight in on an investor´s mind just as much, which are country-specific unrelated. Moving on to the third and last question – And why do it in the context of the EMU? – the EMU is a group of countries that share a transcontinental political project of shared sovereignty, including a common currency. In fact, since the foundation of the Euro in January 1999 and since Greece joined the EMU two years later up until the global credit crunch in August 2007, investors would not differentiate much between EMU member states´ bonds. It would seem that the underlying political unity was not in question. From the later part of 2007 onwards, the spread from an EMU member state 10-year maturity bond *vis-à-vis* the "virtually risk free"[1] counterpart *Bund* started to

[1] *Deutsche Bundesbank*

increase. This increase, however, varied from country to country. It has been argued investors started to question member states commitment to the political project just mentioned. In fact, time and again the Literature uses two determinants which have been put into European law: a limit on both the deficit and the debt level set out by Protocol 12 of the Treaty on the Functioning of the European Union.

This analysis includes a group of indicators as possible determinants of bond spreads, between 1999 and 2014, quarterly data, for 11 members of the euro. Germany 10-year bonds is the benchmark for the spread.

The analysis aims at trying to understand if market participants have in fact regarded the EMU as a block or not, before and during financial turmoil. It was also factored into the present analysis the widely discussed concepts of "core" and "peripheral" countries. Market participants might have considered the EMU either a cohesive set of countries or as 11 distinctive ones. A third option is halfway in between: as two contrasting groups, regarded differently by investors when pricing both of their debts.

The review of Literature is presented in section 2 followed by the Methodology in section 3. Section 4 includes the discussion of the estimation results and section 5 concludes.

2. Literature

The review of Literature below serves to support the study presented in the sections ahead. In each paper mentioned here, it will be made reference to the methodology applied as well as its choice of variables. It may include other useful references.

Afonso and Rault (2010) used a SUR methodology to determine if the estimators for the selected determinants were statistically significant, modeled on real long-run interest rates. It presents several specifications because each SUR model includes a different combination of regressors. Time-wise, this analysis spans between 1973 and 2008, yearly data, and it is carried out for 17 OECD economies. The first model returned that 11 countries had increases in their respective debt-to-GDP ratios raise their respective real long-term interest rates. Such increases ranged from 6 to over 100 basis points (b.p.). In the same model, an improvement in the current account meant a reduction in interest rates for 10 economies. In another specification the debt level is replaced by the budget balance-to-GDP ratio and this flow variable comes out performing just as well as its corresponding stock variable, reducing interest rates between 9 and almost 80 b.p. In yet another specification, it is important to mention increased sovereign liquidity was found to reduce the cost of debt servicing in countries with such diverse economies such as France, Luxembourg and Portugal.

Afonso and Felix (2014), through a panel approach, propose as determinants of 10y government bond spreads, among other explanatory variables, the spread in t-1, the same fiscal performance indicators mentioned above, the real effective exchange rate and a variable to measure international risk, VIX. This analysis covered the time interval from 2000 to the first quarter of 2013 (quarterly data) for 10 EMU countries. The analysis includes a number of specifications, among other reasons, because there are two variables that interchange: the variation of the debt ratio and the budget balance, due to the natural correlation between the two. The spread of the previous year was found to increase the spread of the current year in 0,831 percentage points (p.p.) when last year´s spread had increased 1 p.p., provided the budget balance

was included in the regression. When replaced by the variation of the debt level, the result is approximately the same. An increase in international risk proved to increase spreads on both regressions while GDP growth reduced them, as one can expect. While the rise in the debt level was found to have a say on spreads (0,0017 p.p.), the Budget balance was not. Just as in the first paper mentioned, this one also includes a SUR analysis, also for the same 10 EMU member states. Relating to the specifications mentioned above, the balance is not included in this SUR analysis. The VIX variable performed exceptionally well: it came across as statistically significant in 9 out of 10 countries. As it increased, so did the spreads of these 9 fellow EMU country´s bonds against Germany´s. The real effective exchange rate, and to a lesser extent the spread in t-1, also came out statistically significant in 7 and 4 countries out of 10, respectively. The later variables´ estimates, however, displayed contradictory mathematical signs: while a 1 p.p. increase in last year´s spread increases the current year´s spread for Ireland, the Netherlands and slightly less for Greece, it will reduce France´s by as much as half a p.p. The same situation occurred with the variation of the debt-to-GDP ratio. GDP growth rate performed as expected: higher economic growth reduced spreads, although for very few cross-sections.

Alexopoulou, Bunda and Ferrando (2009) study the convergence of 8 "new" EU countries to the Eurozone, from January 2001 to December of 2008, through a choice of variables modeled on the spreads of these EU member states´ 10y bond yields *vis-à-vis* the Eurozone average equivalent yield. Despite the econometric approach here departing substantially from the analysis presented ahead, it delivers good conclusions worth mentioning, as well as relevant structuring of theoretic concepts. The regressors employed here are grouped in "two main components of spreads": the credit default and the liquidity risk. While macroeconomic and fiscal

fundamentals belong to the former, international financing conditions refer to the later. The authors found statistically significant, among other variables, the current account-to-GDP ratio and the degree of an economy´s openness. Inflation was found to influence the group of countries´ cost of debt service as well.

Arghyrou and Kontonikas (2011) model the 10y bond yield spreads, the counterpart yield being Germany´s, on 3 types of variables: credit risk, liquidity risk and common international risk factor. The analysis covers the time interval between January 1999 and February 2010 (monthly data), including 3 intra-interval analyses: before the Global Credit Crunch (up until August 2007), from November 2007 to February 2009 and from March 2009 until the end of the time frame. It included 10 EMU countries. Throughout these 3 sub-sets of the sample there were shifts in the expectations of market participants. For the analysis of the first decade of the Euro (the methodology was OLS-HAC) there are 4 different specifications, ordered by the increasing number of variables. Looking at the one with the largest number of explanatory variables, the spread in t-1 and the next year expected balance proved significant in 10 and in 8 cross-sections, respectively, and all estimates for each variable carried the same sign, and it being the expected one. An aggregate analysis is carried out for the post-crisis period as well (through fixed-effects GLS cross-section weights): the two previously mentioned variables reaffirm their influence on spreads, plus the liquidity measure. The VIX was not statistically significant in any country individually nor at the aggregate level. In the second interval, however, the VIX is paramount to the pricing of all the countries in the sample. The spread in t-1 goes on to be just as relevant as before.

Yet another paper very much worth mentioning, by Afonso, Arghyrou and Kontonikas (2013), uses a Two-Stage Least Squares panel fixed effects econometric

approach. It models several variables across the 3 groups mentioned in the previous paper, just as the cross-sections, and with the same regressand, between January 1999 and November 2010 (monthly data). It employs dummy variables to allow for different time periods analysis, which coincide with the periods mentioned in the previous paper. Among the variables estimates, the debt-to-GDP ratio (differential against Germany) doubled its effect on spreads between roughly the first decade of the euro (prior to August 2007) and the European Debt Crisis (in this sample between March 2009 and November 2010). The liquidity variable was only significant after March 2009, it being ignored by markets before that. Finally, the international risk variable, despite not significant before the Global Credit Crunch (August 2007), it became increasingly relevant during the period just mentioned, and went on to have a far bigger say on the spread evolution when the Sovereign Debt Crisis was in place (from March 2009 onwards).

Giodano, Linciano and Soccorso (2012), from Jan 2002 and May 2012 for 10 EMU countries, present an aggregate analysis that includes the primary budget balance-to-GDP ratio. This paper has recognized the importance of considering the budget balance free of debt interest payments: it actually portrays countries´ current budgetary performance, unlike simply looking at the budget balance, which is inevitably tainted by the cost of debt servicing. However, it was never found to be significant. Nor was the budget balance. The authors have a detailed grouping classification for the variables under the "fiscal and macroeconomic fundamentals" umbrella: fiscal position, economic activity and external competiveness. The variables that pertain to each group are, in the same order: debt-to-GDP ratio, GDP growth rate (t-1) and current account-to-GDP ratio. All are found significant. The measure of

Liquidity is found to be very important to investors in turbulent times, thanks to the presence of time dummies in the analysis.

In a paper by Kilponenm, Laakkonen and Vilmunen (2012), using daily data (1 Jan 2007 – 21 Mar 2012), it is attempted to capture the developments, among others, of the 10-year government bold yields. It controls for: credit risk, liquidity risk and risk appetite, under OLS (in first differences). A significant number of dummies (over 50) are put forward in this paper: each one accounts for an ECB announcement. The ECB announcements on the months corresponding to the dummies included in the previous papers, and in the analysis ahead as well (Aug 2007 and Mar 2009) are under a larger announcement category named Liquidity, for the decisions throughout this period were to do with increasing liquidity in the market. Contrary to what has been the widely interpretation of the VIX, its estimates come up statistically significant for almost all countries, but bear a negative sign. The authors argue the VIX does not translate general risk appetite as much as the riskiness of the stock market. Therefore, they explain the negative sign as follows: as investor restlessness increases in the stock market (corporate bonds included), sovereign bonds are perceived as a "less risky choice".

3. Methodology

3.1. Cross-sections, dependent and independent variables

This study focuses on the determinants of Sovereign 10y bond yield spreads of 11 EMU countries, *vis-à-vis* Germany´s (dependent variable). It models the spreads on a diversified group variables, based on the Literature: credit risk, liquidity risk and international risk. According to Aßmann and Boysen-Hogrefe (2009), the pricing of 10-year bonds in the Euro area relative to German bond yields reflect "traders' beliefs

about default and liquidity risks rather directly". The cross-sections (*i*) are: Austria, Belgium, Finland, France, Greece, Italy, Ireland, Luxembourg, the Netherlands, Portugal and Spain. In other words, the founding members of the EMU plus Greece. The frequency of the data is quarterly and it ranges from 1999 to 2014. There are some data shortages across the time-series and on both ends of the time frame, which have pushed the need for a robustness model excluding Greece. Such data shortages are duly reported in Table A1 in appendix.

The lag of spreads in t-1 and in t-2 is meant to account for spreads´ persistence (Afonso, Arghyrou and Kontonikas (2013)), in other words, how much do past spreads affect current spreads. Not including them will generate omitted variable bias (Afonso, Arghyrou and Kontonikas (2013)). In turn, lagged spreads are correlated with the country fixed effects. However, these will decrease once the size of the panel time-series reaches 20 observations. Because in this study that threshold is greatly surpassed (T = 4 quarters x 15 years = 60 obs.), one can affirm there is a net benefit from factoring lagged spreads into the model (Afonso, Arghyrou and Kontonikas (2013)). Monthly data would have contributed better for a higher T, notwithstanding, monthly data for fiscal fundamentals is unavailable. Giordano, Linciano and Soccorso (2012) advise it may take some time before the change in a macro variable impacts the sovereign default risk, so a second reason why the lagged spreads for t-2 should be included here. There was also a marginal benefit from adding the second period lagged spreads, as it was noted it improved significantly the Durbin-Watson statistic in this study.

Giordano, Linciano and Soccorso (2012) make the point that as deficit and debt grow, sovereign default risk rises too, thus prompting a surge in the risk premium demanded by the investors. Furthermore, the authors stress high stocks of

debt weaken public debt finance sustainability, since they imply burdensome debt service payments and, consequently, a greater exposure to small changes in interest rates.

The variation of the debt level-to-GDP ratio is an important representative of countries´ fiscal balance sustainability (Alexopoulou, Bunda and Ferrando (2009)).

The budget balance-to-GDP ratio and the primary balance-to-GDP ratio are both are equally interesting, for different reasons. As far as both are concerned, it is often argued that large and unsustainable deficits can endanger the coherence of national macroeconomic policies and may jeopardize the price-stability oriented monetary policy (Afonso and Rault (2010)). But it is relevant to try both variables to understand if investors look solely at the budget balance or bother to look at the primary budget balance instead. The primary balance, because it excludes interest on debt, it allows to see accurately the budgetary performance of the government of the day, without being clouded by the payments on current and past debt. All three fiscal position variables intertwine: according to Alessandrini and Hallet (2014), countries with large debt require larger primary surpluses to offset interest payments on that debt, and go on to say that large budget balances are indicators of a lax fiscal policy, and hence default risk to the extent that they undermine public debt sustainability.

The GDP growth rate is a very important indicator because a fall of the GDP growth rate will lower tax revenues in the future and in turn that will impact a country´s solvency (Giordano, Linciano and Soccorso (2012)). Also, when its rate is subtracted to the yield of sovereign bonds it is an indicator of debt sustainability. If that difference is negative then public finances are on an unsustainable path.

The current account balance-to-GDP is a measure of how a country is positioned internationally, in terms of its net exports. According to Alexopoulou,

Bunda and Ferrando (2009), as an economy becomes more reliant on capital inflows, it becomes more vulnerable to reversals in international flows of funding. Indeed, only Austria managed to avoid a worsening of their current-account balance between the first decade of the Euro and the Global Credit Crunch (see Table 3).

The degree of openness of an economy is computed as follows: $O = \frac{X+I}{GDP}$, and it represents the ability to generate the trade surpluses to secure present debt refinancing (Alexopoulou, Bunda and Ferrando (2009)).

The use of the real effective exchange rate (REER) as a regressor is deemed fundamental because it is an indicator of a country´s competitiveness (Giordano, Linciano and Soccorso (2012)). An increase in domestic prices relative to Euro Area 18 trade partners´ internal prices will harm foreign competitiveness. It will allow to see if bond investors price loss of competitiveness, as an appreciation of the REER deteriorates the terms of trade and spreads are expected to increase.

Inflation is very important due to the fact that higher inflation reduces the real value of debt (Afonso and Nunes (2013)), as it will eat away the real return on a bond by virtue of subtracting to its nominal return. The Literature offers another interesting interpretation for it: an indicator of macroeconomic stability, provided higher inflation implying higher sovereign risk (Afonso and Rault (2010)). In a price-oriented monetary zone such as the EMU, inflation is object of great focus from the Monetary authority.

The Liquidity measure employed here is one out of at least three options available to assess the risk of losses in the case of liquidation (Arghyrou and Kontonikas (2011)). The more liquid a given sovereign bond is, the easier it is to sell it. It is computed as the share of a given country´s outstanding debt in the pool of debt of the 11 EMU countries: $W = \frac{\text{outstanding amount of Central Government debt of country } i}{\sum_1^{11} \text{outstanding amount of Central Government debt of country } i}$.

International risk appetite, as it is put by Giodano, Linciano and Soccorso (2012), is a reasonable proxy for international financial risk (Afonso, Arghyrou and Kontonikas 2012). International risk measures investor risk aversion and it aims at capturing spread movements outside a country´s intervention area: credit risk and liquidity risk.

From the Literature and the Economic interpretation of the variables described above, Table 1 in appendix shows the sign the estimates are expected to carry. For a given increase in the independent variable, a positive sign means it will increase the spread, while a negative sign means it will reduce it.

[Table 1]

Table A2 in appendix provides information on the original frequency of the variables, their source and pertinent specifications.

Table A3 in appendix provides information on the stationarity of the variables used in this study. The Unit Root Fisher – Augmented Dickey Fuller test was ran on all variables (in levels) and it was possible to reject the Null hypothesis that stationarity was not present, for the overall majority of the variables. An alternative would be to use the variables that had failed the test in 1st differences or even to calculate all variables as differentials against Germany´s data. The only variable that was transformed was the variation of the debt-level (originally the debt-to-GDP ratio) because it was the only stock variable in my choice of variables.

It should be mentioned that for the dependent variable it was not possible to reject the H_0 at a 10% level (barely not rejected). The variable did pass this test when the test was run for the variable´s first differences. But I decided against employing the first differences for the spreads because then this study would no longer be on the spreads, but instead on the variation of the spreads.

3.2. Models

The empirical model put forward in 3.2.1 will carry out a panel aggregate analysis. It uses a combination of the regressors and cross-sections described above, as well as different qualitative variables, geography (cross-sections) and time -wise. Such combinations are referred to as specifications. These specifications have arisen, on the one hand, because the variation of the debt-to-GDP ratio, the budget balance and the primary budget balance must interchange between each other, for the "natural correlation" (Afonso and Felix (2015)) between the three. On the other, there is data missing for Greece regarding her fiscal position prior to 2006. Specifications including Greece are baseline specifications. For robustness purposes, the methodology just described was replicated excluding Greece. It was found that on average the baseline specifications deliver a higher number of statistically significant estimates, which is a piece of evidence that supports my decision to define the baseline model as the one including Greece and the robustness model as the one excluding it.

There is another model (3.2.2) that allows for individual country analysis. There, it is no longer useful to make use of the dummies employed in 3.2.1 because the analysis is already country-specific.

3.2.1. Panel Two Stage Least Squares

Contrary to OLS, the 2SLS method is capable of dealing with the independent variable endogeneity problem. Endogeneity in the equation arises when the regressor is not determined 100% outside the system. When it is an endogenous variable, i.e. when it is a function of other variables present in the system, it will make the OLS estimates biased (Nagler (1999)). In this specific context, it is reasonable to assume,

for instance, not only the variation of the debt-to-GDP ratio influences the spread, but also the spread might have influence over the variation of the debt-to-GDP ratio.

The dynamic panel analysis carried out begins with an analysis for the entire time frame and for all cross-sections. A general baseline model specification is as follows:

(1) $S_{it} = cons + \beta_1 \hat{S}_{it-1} + \beta_2 \hat{S}_{it-2} + \beta_3 \widehat{\Delta D}_{it} + \beta_4 \hat{G}_{it} + \beta_5 \hat{E}_{it} + \beta_6 \hat{O}_{it} + \beta_7 \widehat{W}_{it} + \beta_8 \widehat{H}_{it} + \beta_9 \hat{C}_{it} + \beta_{10} \hat{V}_t + \gamma_i + \varepsilon_{it}$, where

– γ_I are the country fixed effects, to reduce omitted variable bias through "soaking up all the across-group action" and "leaving within-group action";

– the set of exogenous independent variables $\{\hat{S}_{it-1}, \ldots, \hat{V}_t\}$ stand for the proxy variables of the endogenous independent variables $\{S_{it-1}, \ldots, V_t\}$.

Such proxies are generated in the first stage of the 2SLS method. In it, we are to find an instrument variable Z_{it} that influences the endogenous regressor $\{S_{it-1}, \ldots, V_t\}$ but that S_{it} does not have influence over Z_{it}. The new estimates for $\{S_{it-1}, \ldots, V_t\}$ include that instrument variable Z_{it} and the exogenous variables from the regression above, for instance, taking the variation of the debt-to-GDP ratio :

(2) $\widehat{\Delta D}_{it} = \widehat{cons} + \hat{\beta}_1 S_{it-1} + \hat{\beta}_2 S_{it-2} + \hat{\beta}_3 Z_{it} + \hat{\beta}_4 G_{it} + \hat{\beta}_5 E_{it} + \hat{\beta}_6 O_{it} + \hat{\beta}_7 W_{it} + \hat{\beta}_8 H_{it} + \hat{\beta}_9 C_{it} + \hat{\beta}_{10} V_t + \nu_{it}$,

where Z_{it} is the 1-period lag of ΔD_{it}. While the 1-period lag of ΔD_{it} still has influence over S_{it}, S_{it} has no influence over the 1-period lag of ΔD_{it}. The econometric software will replicate this process for all the other variables $\{S_{it-1}, \ldots, V_t \setminus \Delta D_{it}\}$, Z_{it} being the 1-period lag of each one of said variables. The second stage of the 2SLS is to insert equation (2) back in equation (1).

Secondly, two different analyses take place. They do so concurrently.

One splits the groups of countries in two: core and peripheral EMU countries. These are two separate regressions – one bears dummy U_i and the other one takes on dummy Q_i, in order to avoid the dummy variable trap. Perfect multicollinearity occurs because dummies were defined for each category: albeit U_i and Q_i are two separate qualitative variables, they are also the categories for each one of them. Since we aim at looking at both core and peripheral countries, both U_i and Q_i are relevant and as a result that leaves us to run two separate regressions to escape the trap. It is most worthy to determine if the countries within each group were looked upon by market participants similarly. These groups were drawn after Afonso, Arghyrou and Kontonikas (2012): the core countries are Austria, Belgium, Finland, France, Luxemburg and the Netherlands and the peripheral countries are Greece, Italy, Ireland, Portugal and Spain.

Another analysis uses time dummies to partition the time frame in three different time periods. This is to check if the determinants influencing spreads of the aggregate of the EMU have shifted according to the time period, these being the following: the first decade of the Euro (roughly) (dummy $Z01_t$), the Global Credit Crunch (dummy $Z02_t$) and the European Sovereign Debt Crisis (dummy $Z03_t$) (See Table A2). They are drawn from Arghyrou and Kontonikas (2011). Again, we have 3 qualitative variables that share the same categories ($Z01_t$, $Z02_t$ and $Z03_t$), so in order to escape the dummy variable trap, either we regress one less regression than the number of categories (so 2 regressions, 1 including 2 dummies), or we estimate one regression per dummy. I chose to do the later.

Thirdly, in an attempt to derive further insight from the data, I return to the time dummies and analyze which determinants are affecting bond yield spreads for each group of countries, one sub-period at a time.

The methodology laid down above has produced a rather large number of regressions and mentioning each one would be unreasonable. So only those delivering statistical evidence of meaningful economic phenomena for the purpose of this analysis will be covered.

3.2.2. Seemingly Unrelated Regressions

A SUR system estimates individual coefficients for each cross-section, as each cross-section gets its own equation. It is more efficient than to estimate each regression on its own with OLS (Afonso and Nunes (2013)). The presence of cross-section dependency renders the OLS estimator inefficient and biased, making its estimates poor candidates for inference (Afonso and Rault (2010)). Table A4 in appendix shows the results for presence of co-integration among the 11 EMU countries chosen here. SUR techniques will alleviate this problem, as long as time series dimension is substantially larger than the number of cross-sections (Afonso and Rault (2010)), which is the case in this study (T = 60 and N = 11). It will assume that both the regressand and the regressors may differ between equations but that contemporary correlation exists between the residuals of all equations (Afonso and Felix (2014)). This model has a single specification (carrying ΔD_{it}) and it is specified as follows:

(3) $S_{it} = cons + \beta_1 S_{it-1} + \beta_2 S_{it-2} + \beta_3 \Delta D_{it} + \beta_4 G_{it} + \beta_5 E_{it} + \beta_6 O_{it} + \beta_7 W_{it} + \beta_8 H_{it} + \beta_9 C_{it} + \beta_{10} V_t$

This model covers the entire time frame. Although this allows for interesting results, it would have been interesting to carry out separate SUR systems for the time sub periods employed here, after what has been done by Arghyrou and Kontonikas (2011). However, the frequency of the data of this study did not allow it: while the authors use monthly data, I use quarterly. This means the authors can afford to break

up the sample in two as they still had 3 times more observations. Adding to that, it would be needed to compute 3 distinct SURs, as there are 3 periods in this study, and not two, as I employ 2 crisis periods, plus a pre-crisis one.

4. Empirical Analysis

4.1. Data

Figure 1 shows the evolution of the 10y bond yield spreads for the set of countries in this study. It also shows when the spread peaked in each time-series. The first vertical line marks a turning point in the EMU: it was between the 2nd and 3rd quarters of 2007 that the Eurozone ceased to enjoy significant homogeneity among its member states´ spreads against the benchmark, the 10y *Bund*.

[Figure 1]

This was due to the Global Credit Crunch that had begun in August that year with the burst of the housing bubble in the US and bad news from BNP Paribas. The second vertical line is to mark March 2009, when said global credit crunch mutated into an European Sovereign Debt Crisis, amid fears for Greek public finances, as well as for other European peripheral countries. Such fears were confirmed later in October 2009 as Greece announced a 12.5% budget deficit. Figure 2 presents a stylized version of Figure 1, grouping EMU countries, Core EMU countries and Peripheral EMU ones.

[Figure 2]

One can see very clearly the two jolts hurting the peripheral EMU economies, the first corresponding to the Global Credit Crunch and the second one owed to the Sovereign Debt Crisis.

Bond market participants´ call on the EMU countries for a premium on their debt was not unjustified, considering investors were uneasy about where to park their money (from 2Q2007 onwards).

[Figure 3]

Also, the Eurozone, on aggregate terms, on average, ran budget deficits during the first decade of the Euro.

[Table 2]

It did present, however, primary budget surpluses during that same time (see Table A5 in appendix).

Such a scenario has direct impact on their borrowing capacity. There are further indicators to support the idea this currency union was not in the investors' good graces at this time. Looking at the differential between GDP growth rate and 10y bond yields, a crucial measure regarding the sustainability of public finances, it was mostly negative for the 11 EMU countries average.

[Figure 4]

Figure 5 shows a significant gap between the cost of debt and economic growth, yet a decreasing one for the 11 countries average, for the first decade.

[Figure 5]

Evidently, the different nature and prestige of the economies involved demanded a closer look. The perceived risk associated with investments in sovereign bonds relative to the safe haven of Germany increased during the global economic downturn (Arghyrou and Kontonikas (2011)). Taking a look at Table 3, core countries had run significant trade surpluses, while peripheral ones had run trade deficits.

[Table 3]

Also, at the end of the first decade of the Euro, peripheral countries were already in violation of the Maastricht Criteria, while Core ones where not.

[Table 4]

So, from the Global Credit Crunch onwards it was all about the "pricing of heterogeneous macro-fundamentals" on a "country-by-country basis" (Arghyrou and Kontonikas (2011)). The illusion of a political understanding among all countries around the issue of pooling everyone´s debt had been shattered. According to Arghyrou and Kontonikas (2011), little after the beginning of the European Sovereign Debt Crisis, Greece was [the first country] transferred from a regime under which there was the perception of fully guaranteed fiscal liabilities to a regime without fiscal guarantees. It should be said though, bond market participants did not proceed to differentiate among the two different types of countries from the onset of the Global Credit Crunch. From contemplating Table 5, yields were only twice higher during this period, compared to 8 times higher during the Sovereign Debt Crisis.

[Table 5]

4.2. Discussion of Estimated Results

4.2.1. Panel Two Stage Least Squares

It was crucial to set *a priori* criteria for analyzing the multitude of results emanating from the 72 regressions of the Panel Two Stage Least Squares approach. Firstly, it is given priority to the baseline regressions. If deemed interesting, reference will be made to the counterpart regressions – the robustness ones. Secondly, the performance of the 3 fiscal position variables will be compared. That performing less well will be foregone. Thirdly, only after considering the time cross-section dummies separately, will it be shed light on the estimates from the combination of both types of dummies.

Table 6 shows the baseline model specifications where the variation of the debt-to-GDP ratio, the government balance and the government primary balance interchange.

[Table 6]

Specification (3) includes the primary balance. Its estimate is not statistically significant, nor will it be so in the Greece excluded regression. This is in tune with the findings of Giordano, Linciano and Soccorso (2012). The variation of the debt-to-GDP ratio estimate in (1) is statistically significant: if it increases by 10 p.p. the spread of the 11 EMU countries will increase 0,14 p.p., on average, *ceteris paribus*. Had Greece not been included, it would have not been significant, though it carried the expected sign. Specification (2) uses the budget balance as the fiscal position variable, and not only its estimate comes out significant, but also it has a greater impact on the spread than the variation of the debt level: for an increase of 10 p.p. in the budget balance, i.e. an increase in the current fiscal surplus, the spreads are expected to decrease close to half a p.p. Had Greece been excluded, the impact is still visible, but smaller, a little over a quarter of a p.p. This is reasonable because Greece was the country with the worst fiscal position and at the same time whose spread peaked the most, so it will not influence results as much.

Looking at the baseline regressions, and fiscal position variables aside, the overall majority of the other estimates were not significant. The same took place regarding the robustness regressions. The analysis so far was for the aggregate set of countries and considered the entire time spectrum of the analysis. As it was possible to understand, hardly any determinants can be said to influence spreads.

The Literature has pointed to the time-varying nature of spreads: the analysis of structural changes in the links between the risk factors (all regressors) and

sovereign spreads, pointing to markets pricing determinants depending on specific time periods. Checking table A2, there are 3 dummy variables of this kind. To begin with the first, Z01, there is little insight that can be reported. It was found for the baseline regression using the variation of the debt level, the spreads increased when said variation increased. The effect is weaker for the robustness regression.

[Table 7]

Despite this is contrary to widespread reasoning (because the sign is negative), this situation is very clear in Figure 6: average spread decreases as debt level increases.

[Figure 6]

This is in line with Literature reports that linkages between spreads and fundamentals were not activated before August 2007 (Afonso, Arghyrou and Kontonikas (2013)). So here too it may be concluded that market participants were not pricing any of the determinants during the first decade of the EMU. Other than this, neither the baseline nor the robust regressions carrying either the budget balance or the primary budget balance were insightful. The results for Z02 and Z03 were equally barren. This points out for yet again no active linkages between the determinants in table A2 and spreads, when considering the aggregate analysis, between the 3rd quarter of 2007 and the 1st quarter of 2009 and 2nd quarter 2009 and 4th quarter of 2014, respectively.

Other qualitative variables have been introduced in this field of study, cross-section-wise: dummies for the separate analysis of two groups of countries.

Table 8 shows the relevant results from the dummies introduced for the Core and Peripheral groups.

[Table 8]

Looking at (1), the spreads from the previous year seem to weigh on the current spreads, and do so considerably. However, an increase in spreads of two years ago seems to disburden current spreads, contrary to what would be expected. Such mixed signals are present in previous specifications in this study (see Table 6). A 10 p.p. budget balance increase relief spreads by approximately half a p.p. for the aggregate group. If considering the Core group exclusively, when said budget balance increase takes place, spreads increase by half a p.p. approximately. So an increase in the fiscal surplus is expected to increase Core country´s spreads *vis-à-vis* Germany´s. This is of course unexpected and an unreasonable estimate. In (2), the only difference is the budget balance is replaced by the variation of the debt-to-GDP-ratio. When looking at the aggregate group, spreads increase by roughly a quarter of a p.p. when there is a variation of 1 p.p. of the debt-to-GDP ratio. So a fiscal deterioration from the point of view of the variation of debt is less impactful than from the budget balance standpoint. If considering Core countries only, the same increase in ΔD_{it} causes these countries' spreads to decrease by roughly a quarter of a p.p., which is an unexpected estimate. In (3) and (4) one can find more or less the same results, but less pronounced, as Greece is excluded here. An important conclusion to take from Table 8 results is the following: while a fiscal deterioration at the 11 EMU level inflicts on spreads, Core countries' spreads seem to not take a hit, as the estimates for this group offset almost completely the estimates for the whole set of countries. This is reasonable given Core countries have hardly exceeded Maastricht Criteria limits throughout the lifetime of the Euro, even during the European Sovereign Debt Crisis (see Tables 2 and 4).

Regarding the combination of dummies U and Q with the dummies Z01, Z02 and Z03, they will allow for the most drill down in this study. It should come as no

surprise its regressions estimates are far less depleted of investor pricing evidence considerations, given we will be examining specific groups of countries in specific time periods.

Before any financial turmoil, there is no evidence for the Core countries of bond market participants concern for pricing spreads. Regarding the same period, for the Peripheral group, Table 9 regression (1) shows there is once again evidence of an increase in the variation of the debt levels leading to a decrease in spreads.

[Table 9]

This is evidence in favor of the "Convergence Trade Hypothesis" (Afonso, Arghyrou and Kontonikas (2013)) which states investors were buying bonds of peripheral European governments in the hope that their yields would converge with those of Germany´s. It would also seem markets were not pricing correctly the worsening of EMU Peripheral´s fiscal position

[Figure 7]

From the figure above, as the debt level increased, the spread decreased.

When Greece is not taken into account, this evidence is no longer statistically significant. And this is reasonable because the average debt level for this period without Greece decreases 10 p.p.

For the period between August 2007 and March 2009 there was a global contraction in credit. The combination of dummies described above will test if that affected in any way the spreads any side of the EMU, or both. For the Core of the Eurozone not one of the regressors in Table A1 had a statistically significant coefficient. I would have expected at least for the VIX to come out having had a say on spread evolution during this time period. It was even found that the VIX estimates did not carry the expected sign, if of course we consider VIX as a measure of investor

overall restlessness. As far as the Peripheral EMU is concerned, the outcome of the baseline regressions was equally uneventful. For the robustness regressions, i.e., excluding Greece, those proved to be a good back up and a last hope in this study for some understanding as to what drove up the spreads for Ireland, Italy, Portugal and Spain, during this period.

[Table 10]

It is a matter worth pondering: once Greece is excluded, several coefficients become statistically significant (at least those from variables G_{it}, E_{it} and C_{it}). This leads one to think Greece´s debt was priced differently and separately from Southern Europe´s and Ireland´s for the better part of the Global Credit Crunch. In subsection 4.2.2 ahead it is presented further evidence of this, for the entire time frame. Coming back to Table 10, we can see that increases in the GDP growth rate and the Real Effective Exchange rate were welcomed by investors, especially the former: a 1 p.p. increase would bring about a spread reduction of the same order of magnitude. Moreover, sovereign market agents seemed to have regarded trade surpluses in an even more favorable light: a given increase in the Current Account-to-GDP ratio would have reduced spreads in these 4 countries 1 ¼ times that surplus increase. Lastly, it should be noted spreads here suffered too from international markets volatility: 1 p.p. increase in CBOE´s VIX Index increased spreads by almost a quarter of a p.p. In spite of it all, this good feedback is forcibly offset by some other estimates that were dissonant, chiefly that an increase of 1 p.p. in the liquidity of the 4 countries´ bond market increased the spreads 39 times, on average, *ceteris paribus*. Both the size of the coefficient and its sign are ludicrous.

Having arrived at the period comprising the Sovereign Debt Crisis until 2014 and looking at the estimates for the Core EMU (available upon request), no

significant estimates were accounted for. Once again no insight is available for the developments of this side of the EMU´s determinants. Table 11 shows the results for the Peripheral EMU.

[Table 11]

Both regressions (1and 2, where two fiscal position variables interchange) carry interesting results. Good fiscal performance (B_{it} and D_{it}) and Economic growth (G_{it}) impact positively on EMU´s peripheral countries and therefore help explain EMU peripheral spreads developments after 2009:Q1. Inflation increase aggravates spreads: this is expected, since investors will demand a higher nominal yield as higher inflation reduces real return on sovereign bonds. Running trade surpluses has also been priced by investors. Despite of this, a higher degree of economic openness and higher market liquidity seem to aggravate spreads, as its coefficients are statistically significant and carry a positive sign. These are of course carrying the wrong sign. The VIX estimate sign can only be considered if one interprets VIX as a measure of stock markets volatility and bond markets a safe haven.

From regressions (3) and (4) there is some evidence of market different pricing treatment for Greece that had been found during the Global Credit Crunch somewhat changed, judging by the statistical significance of some variables´ coefficients.

4.2.2. Seemingly Unrelated Regressions

Firstly, the SUR exercise presents further evidence that Greece has been perceived by markets differently from the rest of the EMU Periphery, on average, for the total time frame. Looking at Figure 1, it can be seen that Greece was the EMU member state which saw its spreads peak the most regarding the benchmark member state, Germany. Additionally, the second country to have its spreads peak the highest

was Portugal, which only peaked nearly half of Greece´s. In Table 12, Greece is shown to have had her spreads influenced by developments in the Real Effective Exchange rate, while the average of the EMU Periphery (Greece excluded) had its spreads influenced by developments in their Current Accounts, on average, *ceteris paribus* (see Table 13). Albeit many theories argue for the strong correlation between terms of trade and net exports, namely a real depreciation of the Real Effective Exchange rate leading to an improvement in the Current Account, there is little evidence supporting that (Chinn and Lee (2006)).

[Table 12]

Secondly, Table 12 points to markets having priced sovereign debt according to the member state specifically, for the total time frame. Going back to the results in Table 6, Inflation is the only variable more inclined to having had an effective say over investor behavior towards EMU bonds, as it comes out statistically significant in specifications (1) and (2): a 1 p.p. increase in inflation causes spreads to increase between 0.53 and 0.68 p.p. But this is a generic effect that can be applied to any other asset: if the rate of inflation rises, investors will demand a raise in the nominal return. When exploring the SUR system, investors priced the sovereign debt of Austria, Belgium, Finland, France, Luxemburg and the Netherlands after international markets volatility, but so too those of Italy´s and Portugal´s. However this is not evidence contrary to country-specific pricing, as VIX does not reflect country-specific data. Furthermore, other than investor fear (VIX) and spreads persistence (S_{it-1}), neither the Core group nor the EMU Periphery share, in a consistent manner, any of the determinants.

Thirdly, the fact that VIX was reported to have taken a toll on some country´s spreads and not on others, relates to the intuition of the VIX by Attinasi, Checherita

and Nickel (2010): in times of heightened uncertainty it could be higher for some euro area countries than for others. Nevertheless, it showed itself almost as impactful as compared to the VIX on the SUR analysis by Afonso and Felix (2014).

Fourthly, it should be noted that Portugal was the only country to have the expected positive sign for the estimates of S_{t-2}, although mixed signs for lagged spreads estimates has been documented in the Literature before (Afonso and Felix (2014)).

5. Conclusion

In this thesis were conducted Panel and SUR analyses to attempt to unveil meaningful determinants of 10-year Sovereign Bond yield spreads for 11 EMU member states, between 1999 and 2014, monthly data. Some of the main results are outlined below.

Looking at the differential between GDP growth rate and 10y bond yields, it was mostly negative for the 11 EMU countries average, a sign of unsustainable public finances.

There was evidence that most determinants were not being priced before August 2007. Also, Greece was priced differently from the remainder of the EMU periphery during the Global Credit Crunch. Furthermore, good fiscal performance and economic growth are taken into account: when bond market participants have priced EMU peripheral debt during the Sovereign Debt Crisis in Europe.

It was found that, on average, for the entire time frame, a 10 p.p. increase in the budget balance, decreased spreads by nearly half a p.p. Had Greece not been factored in, the decreasing amount nearly halved. This is close to portraying Greece as an outlier in the EMU.

Other findings are: there was some evidence markets did not regard the primary fiscal balance in their pricing of sovereign debt and there was strong evidence for the "Convergence Trade Hypothesis".

For future analysis, I would include other types of regressors, namely: to assess contagion effects among EMU member states, e.g. Greece´s spread; to incorporate investor asset return reasoning into the model, e.g. real return in the previous period; and use expected as opposed to current period data, for the GDP growth rate and other variables such as those measuring fiscal performance.

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Table 1: The expected sign of regressors' estimates

Variable classification	Spreads´ persistence		Credit Risk								Liquidity Risk	International Risk
			Fiscal and Macroeconomic Fundamentals									
			Fiscal Position			Economic Activity		External Competitiveness				
Independent Variable	S_{it-1}	S_{it-2}	ΔD_{it}	B_{it}	P_{it}	G_{it}	H_{it}	O_{it}	C_{it}	E_{it}	W_{it}	V_t
Expected influence on the Dependent Variable	+	+	+	–	–	–	+	–	–	+	–	+/-

Table 2: Budget balance-to-GDP ratio (%)

Time period	11 EMU average	EMU Core average	EMU Peripheral average	AT	BE	FI	FR	GR	IE	IT	LU	NL	PT	ES
Z01	-1,32	-0,35	-2,48	-2,61	-0,66	3,80	-2,49	-6,59	1,19	-3,02	0,55	-0,69	-4,54	0,57
Z02	-1,39	0,57	-3,74	-1,58	-0,41	4,76	-2,86	-8,50	-3,31	-2,42	3,50	0,03	-3,46	-1,01
Z03	-5,62	-3,02	-8,74	-3,05	-3,97	-2,11	-5,39	-10,47	-13,29	-3,64	0,21	-3,84	-7,42	-8,88

Table 3: Current Account balance-to-GDP ratio (%)

Time Period	11 EMU average	EMU Core Average	EMU Peripheral average	AT	BE	FI	FR	GR	IE	IT	LU	NL	PT	SP
Z01	0,15	4,26	-4,71	1,13	3,32	5,73	0,85	-7,19	-1,37	-0,94	10,42	4,97	-9,00	-5,06
Z02	-2,37	2,79	-8,56	4,35	-1,08	2,34	-1,63	-14,17	-5,26	-2,72	8,62	4,16	-11,78	-8,88
Z03	0,17	2,36	-2,32	2,30	-0,69	-0,23	-1,53	-5,44	2,37	-1,21	6,01	8,29	-5,03	-2,29

Table 4: Debt-to-GDP ratio (%)

Time period	11 EMU average	DE	EMU Core average	EMU Peripheral average	AT	BE	SP	FI	FR	GR	IE	IT	LU	NL	PT
Z01	62	63	56	70	70	105	50	40	62	104	31	105	6	50	59
Z02	61	65	53	70	68	91	37	33	67	107	34	102	10	47	70
Z03	88	77	68	113	81	104	74	50	87	154	102	121	21	63	112

Table 5: 10-year bond yield spreads averages (p.p.)

Time period	11 EMU average	EMU Core average	EMU Peripheral average	AT	BE	FI	FR	GR	IE	IT	LU	NL	PT	SP
Z01	0,14	0,05	0,25	0,14	0,18	0,13	0,08	0,54	0,12	0,26	-0,34	0,08	0,20	0,14
Z02	0,51	0,39	0,67	0,40	0,44	0,32	0,26	0,94	0,70	0,70	0,64	0,26	0,58	0,41
Z03	2,35	0,54	4,52	0,57	0,98	0,34	0,62	9,74	3,39	2,31	0,39	0,36	4,74	2,39

Table 6: Spreads are modeled on the variables below. Baseline model: Specifications (1) Debt, (2) Balance and (3) Primary Balance

	(1)	(2)	(3)
cons	-1.865643	-4.344690***	-4.614988
S_{t-1}	1.317044***	1.284170***	1.372468***
S_{t-2}	-0.411749***	-0.384024***	-0.470422***
ΔD_{it}	0.013521***		
B_{it}		-0.040137***	
P_{it}			-0.110926
G_{it}	-0.021272	-0.014027	0.022319
E_{it}	0.014868	0.039209***	0.044372
O_{it}	0.168992	0.060548	-0.108775
W_{it}	2.818663	2.315382	0.671531
H_{it}	0.053360**	0.068247***	0.173396
C_{it}	-0.017373	-0.010885	0.029010
V_t	-0.005141	-0.000824	-0.004750
Adj. R^2	0.96	0.96	0.93

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=11; The instruments are the 1 period lag of each regressor; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 7: Spreads are modeled on the variables below. Baseline regression (1) and Robustness regression (2), in period Z01

	(1)	(2)
cons	-8.710510	-0.352593
S_{t-1}	1.361706***	1.339922***
S_{t-2}	-0.443593***	-0.486935***
ΔD_{it}	0.074035***	0.034906***
G_{it}	0.031477	0.013876
E_{it}	0.048993	-0.007123
O_{it}	2.482409	0.891948
W_{it}	3.236360	-0.909502
H_{it}	0.086006	0.082944*
C_{it}	-0.023611	-0.007104
V_t	0.008311	-0.001129
S_{t-1}*Z01*	-10.40794	-2.541023
S_{t-2}*Z01*	9.735352	2.608559
ΔD_{it}*Z01*	-0.078082***	-0.035860***
G_{it}*Z01*	0.118714	0.014754
E_{it}*Z01*	-0.001144	0.000568
O_{it}*Z01*	0.258837	0.023953
W_{it}*Z01*	0.207287	-0.013595
H_{it}*Z01*	-0.072740	-0.059984
C_{it}*Z01*	-0.001413	0.031235*
V_t*Z01*	0.011976	-0.000131
Adj. R^2	0.93	0.96

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=11 (1) and N=10 (2); Robustness model excludes Greece; The instruments are the 1 period lag of each regressor; Z01 refers to [1999:Q1,2007:Q2]; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 8: Spreads are modeled on the variables below. Baseline model: Specifications (1) budget balance and (2) variation of debt-to-GDP ratio; Robustness model: (3) budget balance and (4) variation of debt-to-GDP ratio (all 4 with Core dummy)

	(1)	(2)	(3)	(4)
cons	-2.984464	-1.523978	-2.456973**	-0.534712
S_{t-1}	1.146400***	1.236449***	1.235260***	1.420487***
S_{t-2}	-0.249062***	-0.325590***	-0.329997***	-0.481583***
ΔD_{it}		0.024338***		0.005548*
B_{it}	-0.057904***		-0.052458***	
G_{it}	-0.082201**	-0.056373*	0.015566	-0.013093
E_{it}	0.038585	0.006427	0.033200*	-0.009725
O_{it}	1.619883**	1.841730**	1.571242***	1.354823**
W_{it}	3.323186	3.392205	-1.084854	1.899561
H_{it}	0.142776***	0.108729***	0.088898***	0.014972
C_{it}	-0.065245**	-0.060331**	-0.020791	-0.041762**
V_t	-0.013387	-0.007777	0.007408	-0.001511
$S_{t-1}*Q$	0.018957	-0.222860	-0.069903	-0.406898
$S_{t-2}*Q$	-0.065040	0.162310	0.015895	0.318303
$\Delta D_{it}*Q$		-0.024533***		-0.005744
$B_{it}*Q$	0.052894**		0.047449***	
$G_{it}*Q$	0.088785**	0.061268	-0.008983	0.017988
$E_{it}*Q$	-0.037712	-0.008327	-0.032327	0.007825
$O_{it}*Q$	-1.206312	-1.409949	-1.157671**	-0.923041
$W_{it}*Q$	-2.557601	-2.714275	1.850440	-1.221631
$H_{it}*Q$	-0.123188**	-0.087857	-0.069309**	0.005900
$C_{it}*Q$	0.066602*	0.064604	0.022147	0.046036*
V_t*Q	0.019426	0.014627	-0.001369	0.008362
Adj. R^2	0.96	0.96	0.97	0.96

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=11 (1) (2) and N=10 (3) (4); Robustness model excludes Greece; The instruments are the 1 period lag of each regressor; Core countries are AT, BE, FI, FR, LU, NL; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 9: Spreads are modeled on the variables below. Baseline regression with Peripheral and Z01 time period dummies

	(1)
cons	-2.289558
S_{t-1}	1.296397***
S_{t-2}	-0.399164***
ΔD_{it}	0.019819***
G_{it}	-0.013105
E_{it}	0.020433
O_{it}	-0.026571
W_{it}	4.067818
H_{it}	0.081054***
C_{it}	-0.024360
V_t	-0.008536
S_{t-1}*Z01*U	0.087544
S_{t-2}*Z01*U	-0.096729
ΔD_{it}*Z01*U	-0.021651*
G_{it}*Z01*U	0.044163
E_{it}*Z01*U	0.010037
O_{it}*Z01*U	-0.895988
W_{it}*Z01*U	-1.833715
H_{it}*Z01*U	0.025776
C_{it}*Z01*U	0.091987
V_t*Z01*U	-0.007329
Adj. R^2	0.96

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=11; The instruments are the 1 period lag of each regressor; Peripheral countries are GR, IE, IT, PT, SP; Z01 refers to [1999:Q1,2007:Q2]; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 10: Spreads are modeled on the variables below. Robustness regression with Peripheral and Z02 time period dummies

	(1)
cons	-0.155451
S_{t-1}	1.537574***
S_{t-2}	-0.621817***
ΔD_{it}	0.000710
G_{it}	0.000140
E_{it}	-0.004641
O_{it}	0.384714
W_{it}	3.005238
H_{it}	-0.007196
C_{it}	0.001929
V_t	-0.001318
S_{t-1}*Z02*U	13.70126**
S_{t-2}*Z02*U	-49.11148**
ΔD_{it}*Z02*U	-0.232250
G_{it}*Z02*U	-0.972949*
E_{it}*Z02*U	-0.199957**
O_{it}*Z02*U	6.784358*
W_{it}*Z02*U	39.22786**
H_{it}*Z02*U	0.625533
C_{it}*Z02*U	-1.263334*
V_t*Z02*U	0.229739**
Adj. R^2	0.84

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=10; Robustness model excludes Greece; The instruments are the 1 period lag of each regressor; Peripheral countries are IR, IT, PT, SP; Z02 refers to [2007:Q3,2009:Q1]; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 11: Spreads are modeled on the variables below. Baseline regressions: Budget balance-to-GDP ratio (1) and variation of Debt-to-GDP ratio (2); Robustness regressions: budget balance-to-GDP ratio (3) and variation of debt-to-GDP ratio (4) (all with Peripheral and Z03 period time dummies)

	(1)	(2)	(3)	(4)
cons	-0.687812	-2.660050	1.412162	0.216366
S_{t-1}	1.252531	0.619842	1.830739**	1.375919*
S_{t-2}	-0.454030	0.054169	-0.849597	-0.492770
ΔD_{it}		-0.000631		1.38E-05
B_{it}	-0.021737		-0.008931	
G_{it}	0.008026	0.001245	-0.006963	-0.006081
E_{it}	-0.000419	0.015321	-0.013651	-0.003430
O_{it}	0.689706	0.845293	0.215782	0.330612
W_{it}	-2.065902	0.268965	-2.624219	-2.627262
H_{it}	-0.013279	-0.031277	-0.003093	-0.007993
C_{it}	0.008214	0.002520	0.011167	0.002919
V_t	0.012072	0.017549	0.000727	0.004858
S_{t-1}*Z03*U	-0.224219	0.712194	-0.794983	-0.031196
S_{t-2}*Z03*U	0.310555	-0.409158	0.595797	-0.101792
B_{it}*Z03*U	-0.078555**		-0.099604***	
ΔD_{it}*Z03*U		0.108495***		0.068770***
G_{it}*Z03*U	-0.146132**	0.014012	-0.146146***	-0.062601
E_{it}*Z03*U	-0.004873	-0.007457	-0.000532	0.009921*
O_{it}*Z03*U	1.916469***	1.688171***	1.544498***	1.492657***
W_{it}*Z03*U	4.772986**	6.054893***	3.031950*	1.855615
H_{it}*Z03*U	0.234121***	0.105142	0.396092***	0.297292***
C_{it}*Z03*U	-0.303332***	-0.280956***	-0.236141***	-0.195211***
V_t*Z03*U	-0.163528***	-0.165575***	-0.149576***	-0.163790***
Adj. R^2	0.94	0.94	0.92	0.93

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=11 (1) (2) and N = 10 (3) and (4); Robustness model excludes Greece; The instruments are the 1 period lag of each regressor; Peripheral countries are GR, IE, IT, PT, SP; Z03 refers to [2009:Q2,2014:Q4]; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 12: Spreads are modeled on the variables below. A SUR methodology with the variation of the debt-to-GDP ratio as the fiscal performance variable

	AT	BE	SP	FI	FR	GR	IE	IT	LU	NL	PT
cons	-1.694739	-3.424466	-2.554782	-1.409619	-2.189952	-64.96017	1.013107	-7.655407*	-2.090313	1.126169	-25.25026***
S_{t-1}	0.995861***	0.749869***	1.285301***	0.697034***	0.906117***	1.138763***	1.267278***	0.925645***	0.831098***	0.494870***	0.882952***
S_{t-2}	-0.319275***	-0.088249	-0.411632***	-0.164952**	-0.106720	-0.420023***	-0.582214***	-0.123502*	-0.015645	-0.205082**	0.015152
ΔD_{it}	0.001887	0.000126	0.001195	0.001376	0.001175	-0.046910	0.053097***	0.001579	0.020353	0.005380*	0.131032***
G_{it}	-0.007936	0.019091*	-0.008379	-0.003913	0.002116	-0.172096	0.024134	0.029333*	0.013172	-0.021971**	0.175817***
E_{it}	0.012398	0.041962*	0.023829	0.008964	0.012827	0.628377*	-0.023342	0.082418**	0.007880	-0.017124*	0.224087**
O_{it}	0.825459***	-0.077102	-1.227905	0.594572***	1.194636	4.915476	0.531278	1.651760	0.406269	0.473247***	4.106234
W_{it}	-10.67342	-10.85707**	5.864837	0.131776	0.749594	-41.77323	31.94280	-5.014964*	-222.6310**	0.314294	-61.05920
H_{it}	0.007531	0.016184	0.043672	0.001847	0.000558	-0.257724	0.134564**	0.069479*	-0.038410	0.017097***	0.092946
C_{it}	-0.001312	-0.004785	-0.017423	-0.002471	-0.008506	-0.127133	0.016938	0.022126	-0.002539	-0.001305	-0.043129
V_t	0.008337***	0.011994***	0.007042	0.007115***	0.006143***	-0.000151	-0.005211	0.021094***	0.007700*	0.003562**	0.035628***
R^2	0.91	0.90	0.95	0.88	0.91	0.95	0.98	0.95	0.94	0.88	0.97

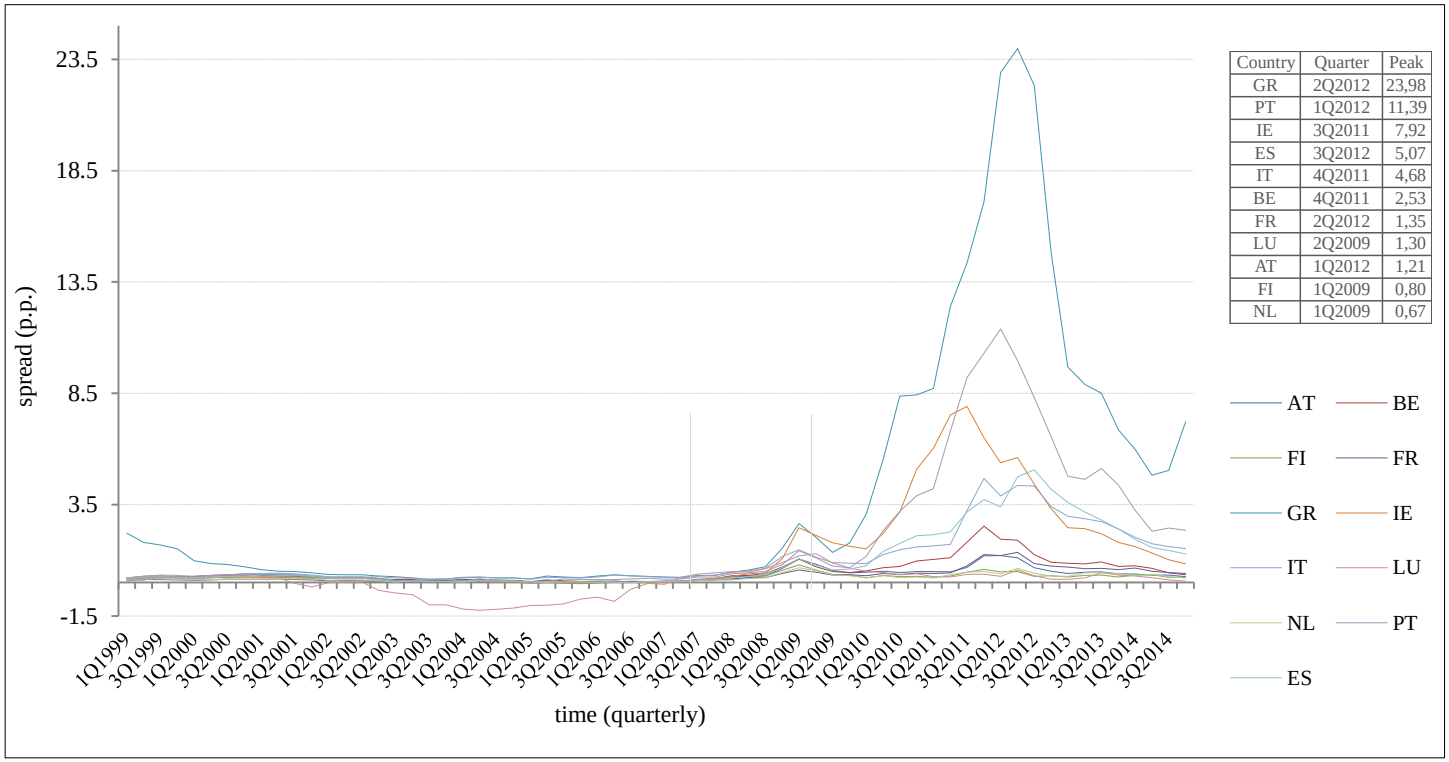
Seemingly Unrelated Regressions system of equations; [1999:Q1,2014:Q4]; N=11; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

Table 13: Spreads are modeled on the variables below. Robustness model with Periphery dummy

	(1)
cons	-0.534712
S_{t-1}	1.013589*
S_{t-2}	-0.163280
ΔD_{it}	-0.000195
G_{it}	0.004895
E_{it}	-0.001900
O_{it}	0.431782
W_{it}	0.677930
H_{it}	0.020872
C_{it}	0.004274
V_t	0.006851
$S_{t-1}*U$	0.406898
$S_{t-2}*U$	-0.318303
$\Delta D_{it}*U$	0.005744
$G_{it}*U$	-0.017988
$E_{it}*U$	-0.007825
$O_{it}*U$	0.923041
$W_{it}*U$	1.221631
$H_{it}*U$	-0.005900
$C_{it}*U$	-0.046036*
V_t*U	-0.008362
Adj. R^2	0.96

2SLS country fixed effects; [1999:Q1,2014:Q4]; N=10; Robustness model excludes Greece; The instruments are the 1 period lag of each regressor; Periphery countries are IE, IT, PT, SP; The asterisks *** ** * indicate significance at the 1, 5 and 10 % level, respectively

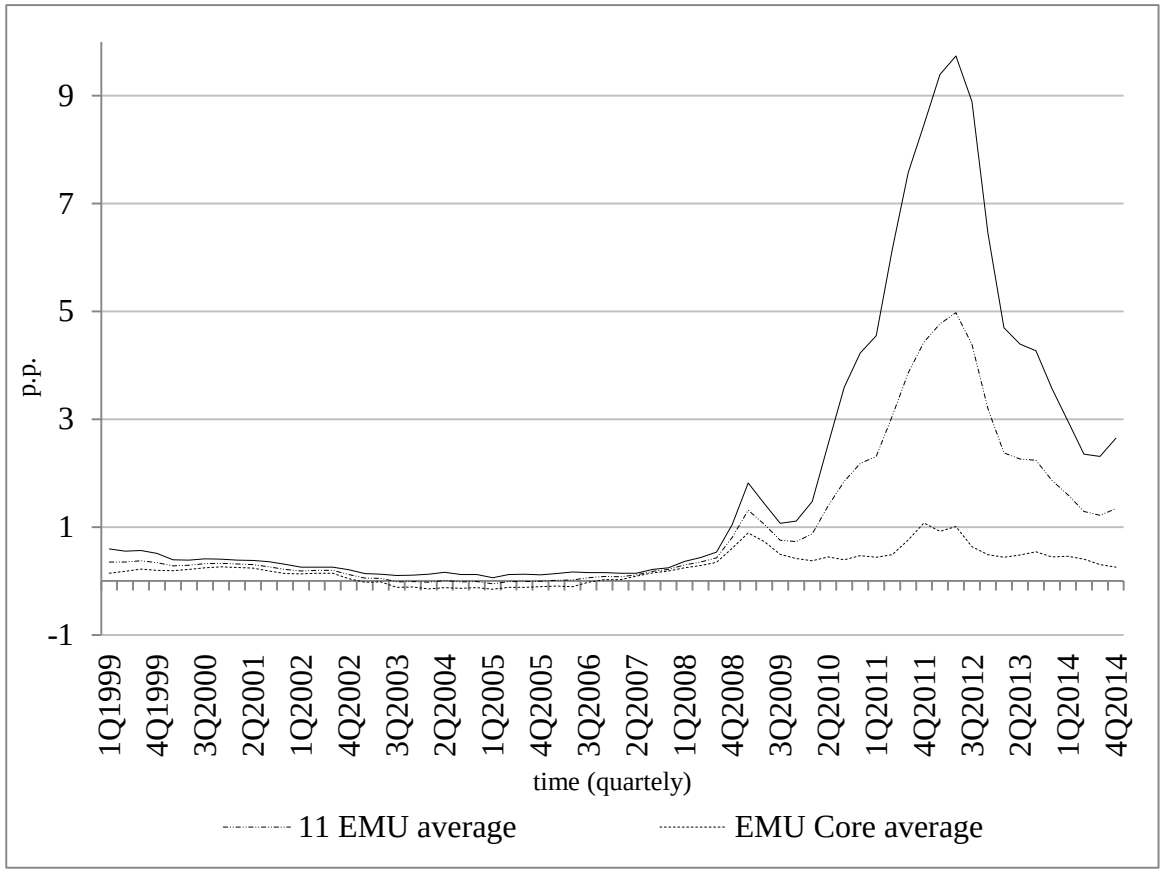
Figure 1: 11 EMU 10-year bond yield spreads *vis-à-vis* Germany´s



Country	Quarter	Peak
GR	2Q2012	23,98
PT	1Q2012	11,39
IE	3Q2011	7,92
ES	3Q2012	5,07
IT	4Q2011	4,68
BE	4Q2011	2,53
FR	2Q2012	1,35
LU	2Q2009	1,30
AT	1Q2012	1,21
FI	1Q2009	0,80
NL	1Q2009	0,67

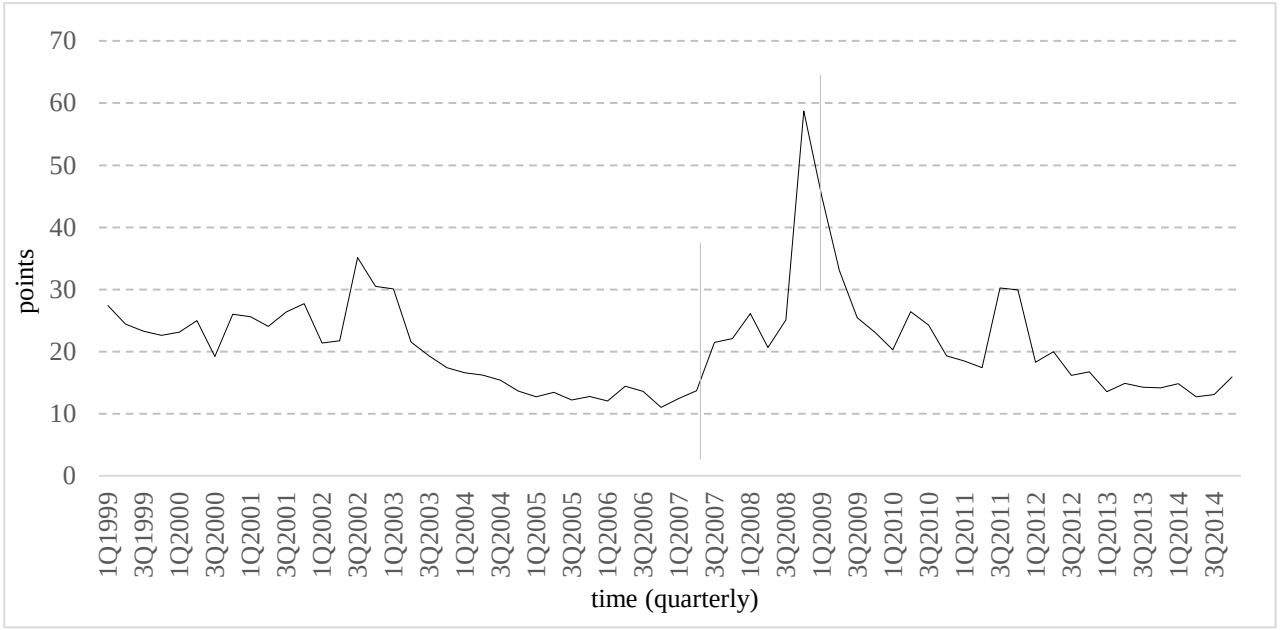
Note: the in-figure table (top-right corner) displays the peak for each time series and the time at which it peaked (e.g.: Portugal´s spread vis-à-vis Germany´s peaked in the 2nd quarter of 2012 at 11,39 p.p.

Figure 2: EMU 10-year bond yield spreads vis-à-vis Germany´s



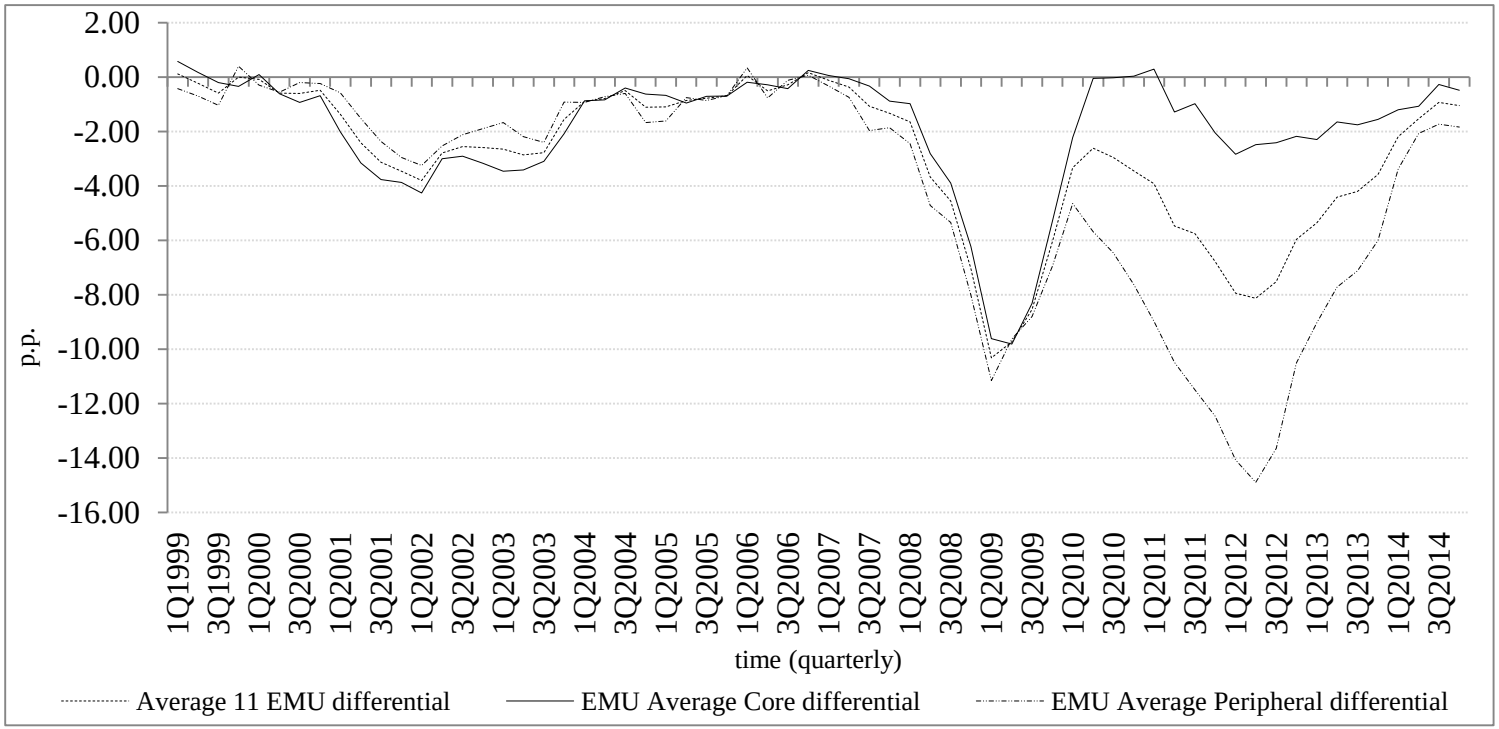
Note: Core countries are AT, BE, FI, FR, LU, NL and Peripheral countries are GR, IE, IT, PT, SP

Figure 3: CBOE VIX



Note: CBOE VIX stands for Chicago Board Options Exchange Volatolity Index, "to reflect investors' consensus view of future expected stock market volatility"; The first vertical line marks 2007:Q2, roughly the fist decade of the euro, and the onset of the Global Credit Crunch. The second vertical line marks 2009:Q1, which stands for the beginning of the European Sovereign Debt Crisis

Figure 4: Differential between GDP growth rate and 10y bond yield



Note: The differential is computed as the difference between the GDP growth rate minus the 10y bond yield, for the 11 EMU countries, EMU Core countries and EMU Periphery countries, separately. Core countries are AT, BE, FI, FR, LU and NL. Peripheral countries are GR, IT, IE, PT, SP.

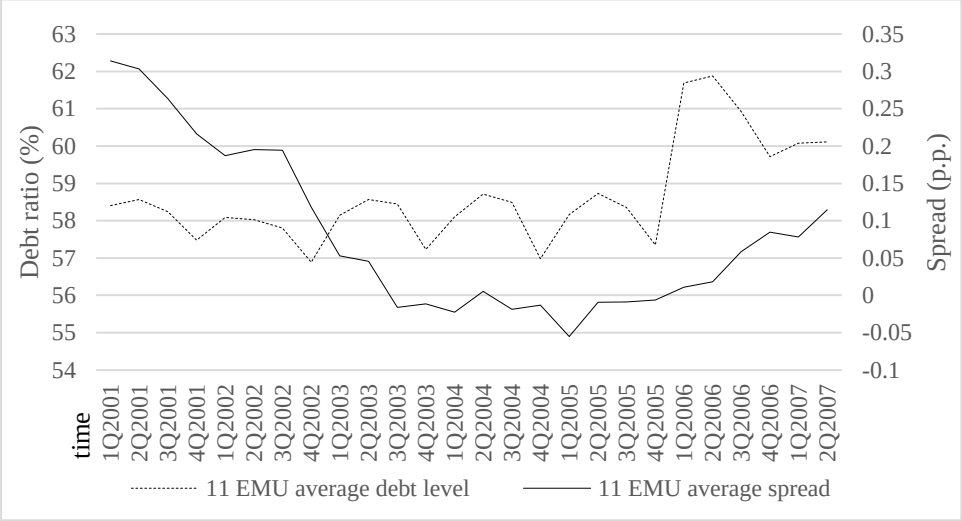
Figure 5: Average GDP growth rate and average 10y bond yield for 11 EMU, Core EMU and Peripheral EMU countries

Average 11 EMU 10-year bond yields
(full line)
Average 11 EMU GDP growth rate
(dashed line)
11 EMU countries are AT, BE, FI, FR, GR, IE, IT, LU, NL, PT, SP

EMU average Core 10-year bond yields
(full line)
EMU average Core GDP growth rate
(dashed line)
Core countries are AT, BE, FI, FR, LU, NL

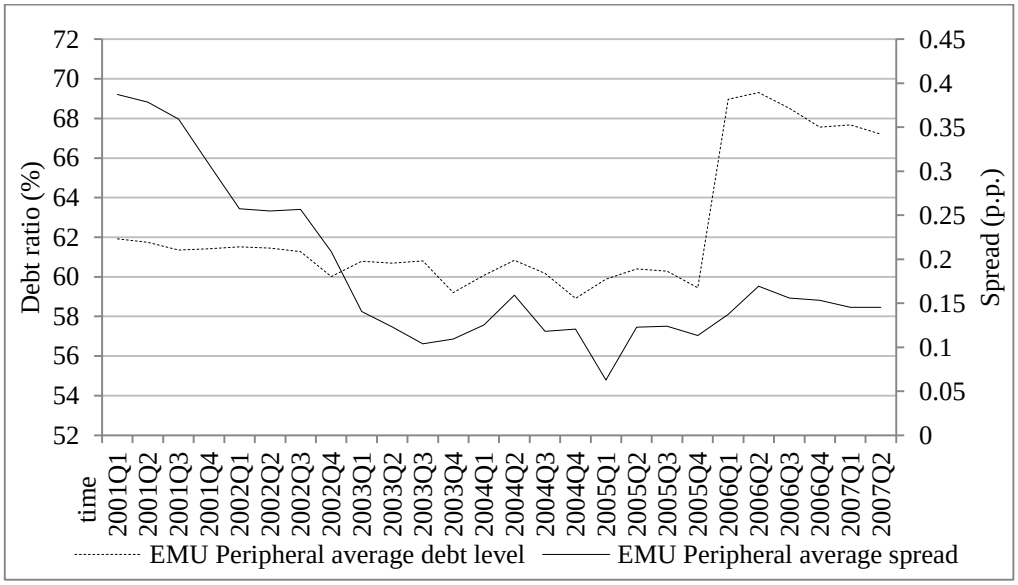
EMU average Peripheral 10-year bond yields
(full line)
EMU average Peripheral GDP growth rate
(dashed line)
Peripheral countries are GR, IE, IT, PT, SP

Figure 6: 11 EMU debt ratio and Spreads



Note: Chart considers Z01 period from 2001:Q1 to 2007:Q2 because estimates from *D* in period Z01 are strongly influenced by data shortages between 1Q1999 and 4Q2000 (see Table A1); 11 EMU countries are: AT, BE, FI, FR, GR, IE, IT, LU, NL, PT, SP

Figure 7: Peripheral EMU debt ratio and Spreads



Note: Chart considers Z01 period from 2001:Q1 to 2007:Q2 because estimates from *D* in period Z01 are strongly influenced by data shortages between 1Q1999 and 4Q2000 (see Table A1); Peripheral countries are GR, IE, IT, PT,

Appendices

Table A1: Data shortages time intervals

Cross-sections / Time-series	AT	BE	GR	IE	IT	FI	FR	LU	NL	PT	SP
S_{it}											
S_{it-1}	(1Q1999)										
S_{it-2}	[1Q1999,2Q1999]										
ΔD_{it}	[1Q1999,4Q2000]		[1Q1999,4Q2006]	[1Q1999,4Q2000]		[1Q1999,4Q2000]		[1Q1999,3Q2001] ∪ (4Q2014)	[1Q1999,4Q2000]		
B_{it}	[3Q2002,1Q1999]		[1Q1999,3Q2006]	[1Q1999,3Q2002]	[1Q1999,3Q1999]			[1Q1999,3Q2002] ∪ (4Q2014)	[1Q1999,3Q1999]		[1Q1999,3Q2002]
P_{it}	[1Q1999,4Q2001]		[1Q1999,4Q2005]	[1Q1999,4Q2001]				[1Q1999,4Q2001] ∪ (4Q2014)			[1Q1999,4Q2001]
G_{it}											
E_{it}											
O_{it}											
W_{it}											
H_{it}											
C_{it}	[2Q2014,4Q2014]		[3Q2014,4Q2014]			[2Q2014,4Q2014]		[1Q1999,4Q1999] ∪ [2Q2014,4Q2014]	[2Q2014,4Q2014]	[3Q2014,4Q2014]	
V_t											

Time intervals refer to missing data periods for the corresponding variable and country; The grey colored area indicates no data is missing for the entire time frame ([1999:Q1,2014:Q4])

Table A2: Variables

Variables		Original frequency	Source	Specifications
Full name	Short name			
10 year bond yield spread vis-à-vis Germany	S_{it}	Monthly	ECB	Long-term [nominal] interest rate for convergence purposes; Debt security issued; 10 years maturity; Own calculations: average of monthly rates
Lagged spreads	S_{it-1} or S_{it-2}	Monthly	ECB	Same period, 1 or 2 years lagged
Variation of Government Debt-to-GDP ratio	ΔD_{it}	Quarterly	ECB	Same quarter of previous year; End of period data.
Government Budget Balance-to-GDP ratio	B_{it}	Quarterly	ECB	Summed through period
Government Primary Budget Balance-to-GDP ratio	P_{it}	Quarterly	ECB	
Nominal GDP growth rate	G_{it}	Quarterly	OECD	Same quarter previous year; seasonally adjusted
Real Effective Exchange Rate	E_{it}	Monthly	GD ECFIN	Base year: 2005; REER vs. EA 18; HCPI deflator; Own calculations: average of monthly rates
Openness Index	O_{it}	Quarterly	OECD	Own calculations
Share of outstanding debt	W_{it}	Monthly	ECB	Outstanding amounts of securities other than shares, excluding financial derivatives; Central government; End of period; Own calculations: average of monthly shares
Inflation	H_{it}	Monthly	Eurostat	Annual rate of change; Base year: 2005; All-Items HICP; Own calculations: average of monthly rates
Current Account Balance-to-GDP ratio	C_{it}	Quarterly	OECD	
VIX	V_t	Daily	CBOE	Own calculations: quarterly averages from daily prices
Geography qualitative variables	U_i (peripheral)	1 if country $i \in$ {GR, IE, IT, PT, SP}, 0 otherwise		
	Q_i (core)	1 if country $i \in$ {AT, BE, FI, FR, LU, NL}, 0 otherwise		
Time qualitative variables	$Z01_t$	1 if $t \in$ [1999:Q1,2007:Q2], 0 otherwise		
	$Z02_t$	1 if $t \in$ [2007:Q3,2009:Q1], 0 otherwise		
	$Z03_t$	1 if $t \in$ [2009:Q2,2014:Q4], 0 otherwise		

Table A3: Fisher-Augmented Dickey-Fuller (ADF) for Individual Unit Root

Variable	Probability	H_0
Sit	0.12	Not rejected
ΔDit	0.00	Rejected
Bit	0.51	Not rejected
Pit	0.57	Not rejected
Git	0.00	Rejected
Eit	0.01	Rejected
Oit	0.01	Rejected
Wit	0.63	Rejected
Hit	0.00	Rejected
Cit	0.00	Rejected
Vt	0.00	Rejected

Model of the Fisher-ADF test is Trend and Intercept; Schwarz Criterion for number of lags; H_0: Variable is not stationary is rejected at a 10% level. H_1: Not H_0

Table A4: Kao Residual Cointegration Test

Variable	Probability	H_0
Sit	0.02	Rejected
ΔDit		
Bit		
Pit		
Git		
Eit		
Oit		
Wit		
Hit		
Cit		
Vt		

Trend assumption: No deterministic trend; Schwarz Criterion for number of lags; H_0: No cointegration is rejected at a 5% level. H_1: Not H_0

Table A5: Primary budget balance-to-GDP ratio (%)

Time period	11 EMU average	EMU Core average	EMU Peripheral average	AT	BE	FI	FR	GR	IE	IT	LU	NL	PT	ES
Z01	1,67	2,41	0,79	0,65	4,51	5,94	0,13	-1,61	2,17	2,26	1,26	1,98	-1,48	2,59
Z02	0,14	1,88	-1,96	0,87	1,71	4,76	-1,23	-5,10	-4,19	1,49	3,29	1,90	-1,21	-0,81
Z03	-2,57	-1,04	-4,41	-0,24	-0,48	-1,06	-2,73	-4,77	-9,41	1,23	0,51	-2,25	-2,97	-6,15